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School of Dentistry
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Influence of Keratinized Mucosa, Bone Dimensions on
Mucosal Recession and Bone Loss

by

Jeanette Keng Ling Chua, DDS

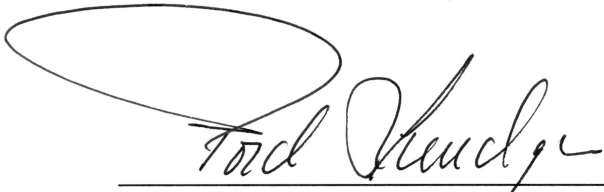
A Thesis submitted in partial satisfaction of
the requirements for the degree of
Master of Science in Periodontics

May 2006

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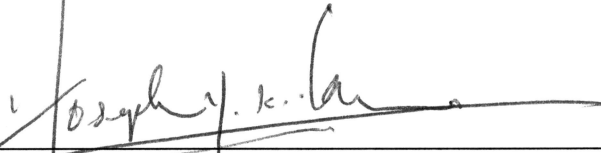
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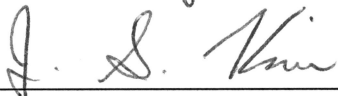


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ABSTRACT OF THE THESIS

Influence of Keratinized Mucosa, Bone Dimensions on
Mucosal Recession and Bone Loss

by

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Master of Science, Graduate Program in Periodontics
Loma Linda University, May 2006
Dr. Tord Lundgren, Chairperson

Background: To accomplish successful esthetic outcome, it would be an advantage if some pre-implant placement conditions could be identified which would predict soft and hard tissue outcomes post-implant placement. This study was designed to evaluate the influence of 1) height of mid-buccal keratinized mucosa at implant surgery and 2) thickness of mid-buccal bone after osteotomy on the amounts of mid-buccal mucosal recession and bone loss during the first year after implant treatment. This report presents the initial 3-month follow-up.

Materials and methods: Nine patients scheduled for surgical placement of a total of 11 single-staged implants, without adjacent teeth and planned for fixed crown restoration, were recruited for this study. The height of keratinized mucosa and thickness of buccal bone after osteotomy were measured prior to implant placement. Upon crown insertion and three months later, mid-buccal probing depth, soft tissue height, levels of mucosal margin and bone crest were measured.

Results: The height of the keratinized mucosa decreased from 5.8 ± 3.0 mm to 2.2 ± 1.5 mm and 2.4 ± 1.9 mm from time of surgery to crown insertion and 3 months later. Calculations of correlations showed tendencies indicating that with decreasing height of the mid-buccal keratinized mucosa and decreasing thickness of the mid-buccal bone after osteotomy there were more mid-buccal mucosal recession and bone loss from crown insertion to 3 months later. However, most of these relationships did not reach statistical significance.

Conclusion: This 3-month report identified some pre-implant placement conditions that seem to predict relevant soft and hard tissue outcomes post-implant placement.

CHAPTER ONE

INTRODUCTION

The use of endosseous implants for anchorage of dental prostheses is a well-documented treatment concept.¹⁻² Besides osseointegration for anchorage of the implant, the establishment of a functional and aesthetic soft tissue 'seal' is considered to be important for success of the treatment.³⁻⁴ This soft tissue 'seal' (distance between mucosal margin to bone crest) has a mean height of about 4 mm⁵⁻¹⁰, while peri-implant probing depth averages around 3 mm.¹¹⁻¹⁶

A proximal marginal bone loss ranging from 0.6 mm to 1.1 mm has been observed within the first year after implant placement.¹⁷⁻¹⁹ Cardaropoli et al. (2006)²⁰ evaluated alterations of bone dimensions at single-tooth restorations from the time of implant placement to 1-year post-loading. A mean loss of bone height amounting to 0.7 mm was observed for facial aspect. They also reported a 0.4 mm reduction of the buccal bone thickness during the first 6 months after implant placement. Spray et al. (2000)²¹ observed significantly more facial bone loss between implant placement and abutment connection surgery for implants that had a facial bone thickness less than 1.8 mm.

The clinical response of the soft tissues surrounding implants has been evaluated extensively.^{11-16,20-26} Only a few of these studies are reporting early changes after implant surgery. Recession of the peri-implant mucosal have been reported to be around 1 mm.^{14,20,22-26} However, the changes have not been related to any pre-surgery local condition.

It would be a great advantage if some pre-implant placement conditions could be identified that would predict relevant soft and hard tissue outcomes post-implant

placement. Thus, this study was designed to evaluate the influence of 1) height of the mid-buccal keratinized mucosa at the time of implant surgery and 2) thickness of the mid-buccal bone after osteotomy on the amounts of mid-buccal mucosal recession and bone loss during the first year after implant treatment. This report presents the initial 3-month follow-up.

CHAPTER TWO

MATERIALS AND METHODS

Subjects

Nine patients scheduled for surgical placement of a total of 11 single-staged implants in the Advanced Periodontics Clinic at Loma Linda University School of Dentistry were recruited for this study. The patients were enrolled into the study between December 2004 and August 2005. Patients were systematically healthy and within 46-84 years of age (mean age of 66). The selected implant sites had no adjacent teeth and were planned for fixed crown restorations. Any extraction had occurred at least 3 months prior to entering the study. Patients were excluded if they were pregnant, smokers, or were using medications that may affect the gingival conditions, such as nifedipine or Ca²⁺ channel blockers. Patient characteristics and implant sites distribution are shown in Table 1. Approval for the study was granted by the Institutional Review Board of Loma Linda University based upon the World Medical Association Declaration of Helsinki.

Implant Procedures

Following verbal and written information to the subjects and receipt of informed consent, any existing periodontal disease was treated. Subsequently, the subjects were enrolled in a 3-monthly periodontal maintenance care program including reinforcement of oral hygiene and professional tooth cleaning. ITI Esthetic Plus implants (Straumann, Waldenburg, Switzerland), diameter 4.1 mm or 4.8 mm with a smooth collar height of 1.8 mm, were inserted according to the manufacturer's protocol. Implant surgeries were performed by four periodontal residents following the same protocol (8 of the 11

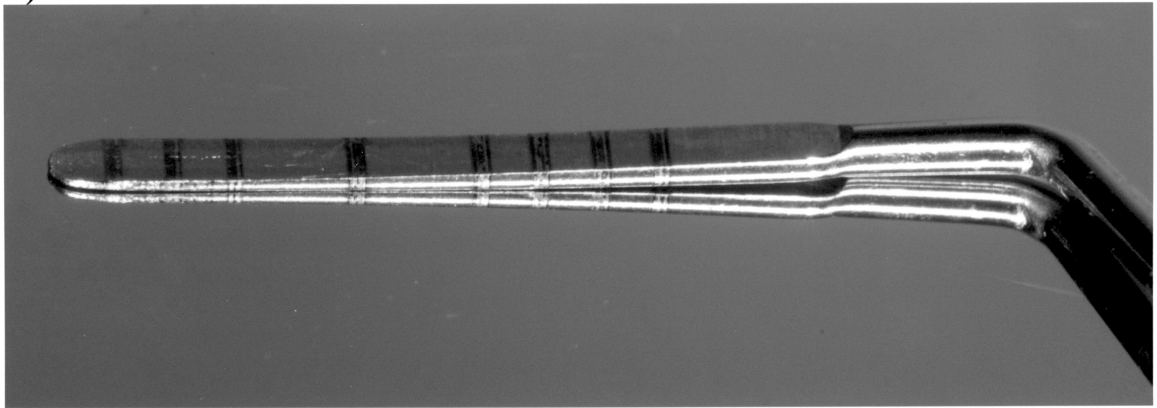
implants by author JKLC). Following local anesthesia, a crestal incision through the middle of the planned implant position was placed. Mesial or distal vertical releasing incisions were used when necessary to facilitate elevation of a full thickness flap. The implants were placed with the junction of the rough/smooth interface at the level of the buccal alveolar crest. Healing caps were placed and the buccal flaps were positioned with the mucosal margin in contact with the healing caps. Wound closure was performed using interrupted sutures. Routine post-surgical radiographs were taken and patients were put on 0.12% chlorhexidine mouth rinse twice daily for 2 weeks. All patients received antibiotics for 10 days starting 1 day prior to surgery. Sutures were removed after 2-3 weeks. During the subsequent healing period, the patients were recalled every 2-3 weeks to monitor the healing events and to ensure that optimum oral hygiene was practiced. Fixed prosthesis were inserted no sooner than 2 months post-implant placement.

Initial Measurement at Implant Surgery

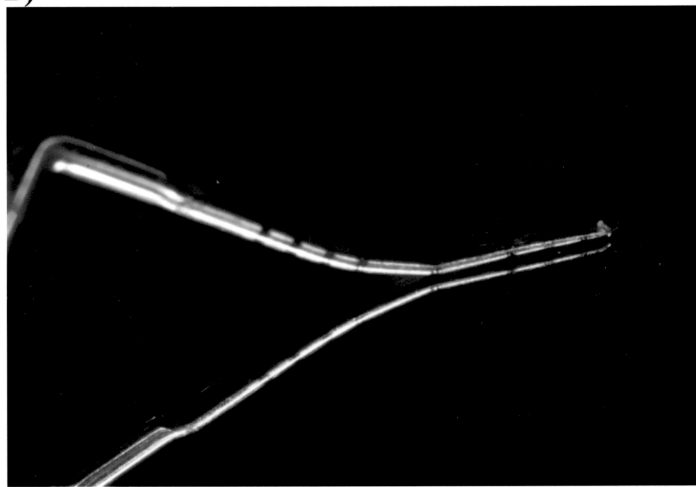
Height of keratinized mucosa: Prior to crestal incision, the height of the keratinized mucosa from the center point of planned implant position to the mucogingival junction was measured to the nearest mm using a flat-end Goldman-Fox probe (PCPGF/W6, HuFriedy, Chicago, IL, USA) (Figure 1).

Thickness of buccal bone following osteotomy: Following osteotomy at the implant site, the thickness of the remaining buccal bone at the crestal level and 3 mm apical to the crest was recorded to the nearest 0.1 mm with a modified boley gauge (modified 10-8018, H & H, Ontario, CA, USA).

A)



B)



C)



Figure 1: A) Goldman-Fox probe (PCPGF/W6, HuFriedy, Chicago, IL, USA) B) Malleable probe for contour of ridge C) Illustration of height of mucosa measurement clinically

Measurement after Crown Insertion

The following measurements were obtained at 2 time points: immediately following crown insertion and after 3 months.

Height of keratinized mucosa: The perpendicular distance from the margin of the mucosa to the mucogingival junction was measured mid-buccally to the nearest mm with the flat-end Goldman-Fox probe.

Probing depth: Probing depth was recorded at the mid-buccal sites of the implants to the nearest mm using the flat-end Goldman-Fox probe.

Soft tissue height: Using the Goldman-Fox probe, penetrating the same mid-buccal sites as for probing depth measurements until contact with bone, the distance from the mucosal margin to bone was measured to the nearest mm ('bone sounding'; height of soft tissue 'seal').

Change of the level of mid-buccal mucosal margin (recession): Polyvinyl siloxane impressions (Exafast, GC America, Alsip, IL, USA) were taken and study casts of the implant sites were produced. A stent was fabricated for each subject (Duralay, Reliance Dental Mfg. Co., Chicago, IL, USA). The stent could be transferred onto study casts taken at different time points. A vertical line was drawn from the mid-buccal mucosal margin of the implant crown to a fixed point marked on the stent. The distance between the fixed point to the mid-buccal margin of the mucosa was measured using the two pointed ends of a compass. The measurement was transferred by indenting two lines onto a piece of paper. The distance between the lines was measured with a boley gauge to the nearest 0.1 mm. Recession was calculated from the change of the distance between crown insertion to 3 months (Figure 2).

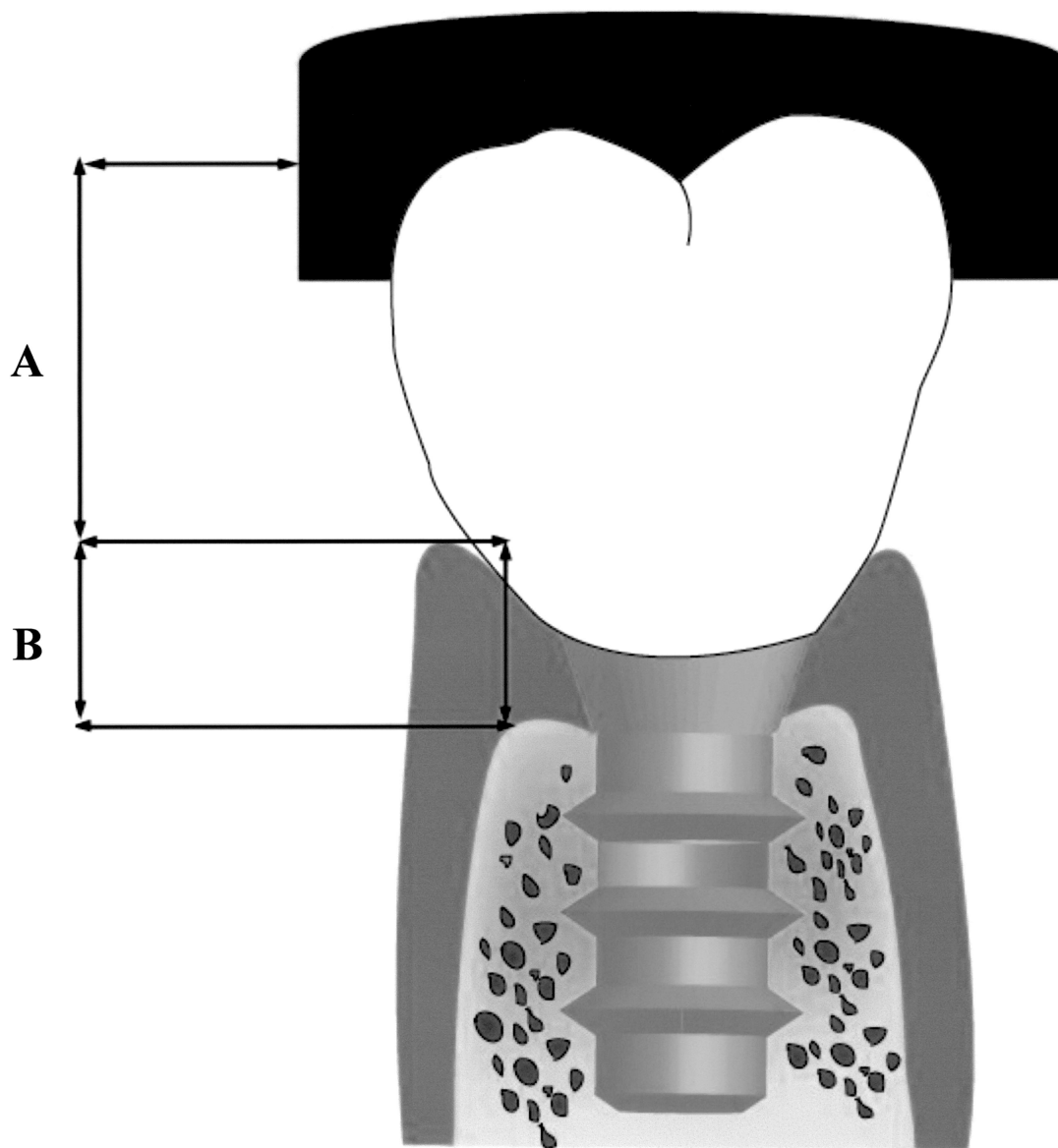


Figure 2: Illustration of mid-buccal recession and mid-buccal bone loss measurements

Recession = A at 3 months – A at crown insertion

Bone loss = (A+B) at 3 months – (A+B) at crown insertion

Change of the level of mid-buccal bone crest (bone loss): The level of the mid-buccal bone crest at crown insertion was obtained by adding the above value for the level of the mid-buccal mucosal margin and the value for mid-buccal soft tissue height. Bone loss was calculated from the change of the distance between crown insertion to 3 months (Figure 2).

Examiners

Measurements of the height of the keratinized mucosa and the thickness of the buccal bone following osteotomy were taken by one examiner (examiner 1). Measurements of probing depth, soft tissue height and level of mid-buccal mucosal margin were obtained by two independent examiners (examiner 1 and 2). Means of the recordings from the two examiners were calculated and used for data analysis. A comparison of available measurements obtained by examiners 1 and 2 revealed that 68% of measurements showed 0 mm difference; 30% \pm 1 mm difference; and 2% \pm 2 mm difference.

Data Analysis

Comparisons of the height of keratinized mucosa at different time points were made using Kruskal-Wallis test followed by Mann-Whitney-U test. The relationships between the various pre- and post-implant conditions were evaluated using Spearman's coefficient of correlation (ρ).

CHAPTER THREE

RESULTS

Mid-buccal Soft and Hard Tissue Measurements

The mean height of keratinized mucosa at time of surgery was 5.8 mm. At crown insertion and after 3 months, the height was reduced to of 2.2 mm and 2.4 mm, respectively. Mean bone thickness after osteotomy were 2.0 mm at the crestal level and 3.3 mm at the 3 mm level. Mean probing depth at crown insertion and 3 months later amounted to 2.7-2.8 mm. Soft tissue heights at both crown insertion and at 3 months were 0.7-0.9 mm larger than the probing depths. Mean mid-buccal mucosal recession and bone loss were 0.4 mm and 0.5 mm, respectively (Table 2).

Relationships between Recordings at Time of Implant Surgery vs. Recordings at Crown Insertion and 3 months after

The height of the keratinized mucosa at time of surgery was significantly correlated to the heights at crown insertion and 3 months later (Spearman's rho = 0.70 and 0.77, respectively) (Table 3).

The initial height of the keratinized mucosa as well as the heights at crown insertion and 3 months later showed negative coefficients of correlation to mucosal recession ranging from Spearman's rho -0.37 to -0.62. Corresponding coefficients for bone loss ranged from Spearman's rho -0.25 to -0.46. Most of these relationships did not reach statistical significance (Table 4).

Bone thickness at crestal and 3 mm levels after osteotomy showed negative coefficients of correlation to mucosal recession amounting to Spearman's rho -0.58 and -0.46, respectively. Corresponding coefficients for bone loss amounted to Spearman's rho

-0.24 and -0.18, respectively. None of these relationships reached statistical significance (Table 5).

Table 1.

Patient Characteristics and Implant Sites Distribution

Patient	Gender	Age	Site
1	M	75	2
2	F	84	4
3	F	46	31
4	F	76	3
5	F	59	3
	-	-	4
6	M	51	25
7	M	59	3
8	M	67	4
9	M	76	30
	-	-	14

Table 2.

Mid-buccal Soft and Hard Tissue Measurements at Time of Implant Surgery (Initial), at Crown Insertion and 3 Months after Crown Insertion in mm. (Mean \pm SD, Range, NA = Not Applicable) (N=11)

	Height of Keratinized Mucosa	Bone Thickness Crestal Level	3 mm Level	Probing Depth	Soft Tissue Height	Mucosal Recession	Bone Loss
Initial	5.8 \pm 3.0* (2.0 - 12.0)	2.0 \pm 1.8 (0.0 - 5.6)	3.3 \pm 1.9 (0.8 - 6.4)	NA	NA	NA	NA
Crown Insertion	2.2 \pm 1.5* (0.0 - 4.0)	NA	NA	2.7 \pm 0.5 (2.0 - 3.5)	3.6 \pm 0.7 (3.0 - 5.0)	NA	NA
3 months	2.4 \pm 1.9† (0.0 - 5.0)	NA	NA	2.8 \pm 0.4 (2.0 - 3.0)	3.5 \pm 0.8 (3.0 - 5.0)	0.4 \pm 0.5 (-0.3 - 1.1)	0.5 \pm 0.7 (-0.3 - 1.1)

* $P = 0.003$.

† $P = 0.007$.

Table 3.

Relationships (Spearman's rho) between Mid-buccal Height of Keratinized Mucosa at Time of Implant Surgery (Initial) vs. Heights of Keratinized Mucosa at Crown Insertion and 3 Months after Crown Insertion

	Initial Height vs.
Crown Insertion Height	0.70*
3 Months Height	0.77†

* $P = 0.017$.

† $P < 0.001$.

Table 4.

Relationships (Spearman's rho) between Mid-buccal Height of Keratinized Mucosa at the Time of Implant Surgery (Initial), at Crown Insertion and 3 Months after Crown Insertion vs. Mid-buccal Mucosal Recession and Mid-buccal Bone Loss after 3 Months

	Initial Height vs.	Crown Insertion Height vs.	3 Months Height vs.
Mid-buccal recession	-0.62*	-0.37 ^{NS}	-0.50 ^{NS}
Mid-buccal bone loss	-0.46 ^{NS}	-0.25 ^{NS}	-0.41 ^{NS}

* $P = 0.042$.

^{NS} Statistically not significant.

Table 5.

Relationships (Spearman's rho) between Thickness of Mid-buccal Bone after Osteotomy at the Crestal Level and 3 mm Apical Level vs. Mid-buccal Recession and Mid-buccal Bone Loss after 3 Months

	Crestal Level Thickness vs.	3 mm Level Thickness vs.
Mid-buccal recession	-0.58 ^{NS}	-0.46 ^{NS}
Mid-buccal bone loss	-0.24 ^{NS}	-0.18 ^{NS}

^{NS} Statistically not significant.

CHAPTER FOUR

DISCUSSION

The aim of this study was to identify some pre-implant placement conditions that would predict relevant soft and hard tissue outcomes post-implant placement. Only two studies seem to be available investigating the effect of pre-implant conditions to post-restoration outcomes.²⁰⁻²¹ These studies have utilized 2-staged implant treatment where a second stage abutment connection surgery had to be performed. The present study utilized 1-stage implants that were restored with fixed prosthesis. An advantage using 1-staged implants is the elimination of second-stage surgery, thus allowing the formation of a 'biologic width' around the implants starting at the time of implant placement.

It has been observed that the level of peri-implant mucosal margin is related to the height of the proximal bone levels of adjacent teeth.²³ Therefore, the inclusion criteria of the present study restricted the selected implants to those without adjacent teeth in order to eliminate a confounding factor that may affect the peri-implant dimensions.

Previous studies of keratinized mucosa around implants have primarily focused on presence or absence of keratinized tissue after prosthesis placement, correlating this to implant survival. These studies have observed presence of keratinized mucosa in 38-74% of cases. No significant correlations to implant survival have been found.¹¹⁻¹³ However, absence of keratinized mucosa around dental implants seems to increase the susceptibility of the peri-implant region to plaque-induced tissue destruction.²⁷⁻³⁰

One of the findings of the present study was the decrease of the height of keratinized mucosa from implant surgery to crown insertion of the implants. The decrease in height may be related to the difference in morphology after implant

placement coupled with change in coronal mucosal reference point. A decrease in height of keratinized mucosa was not observed by Cardaropoli et al. (2006)²⁰ in their 2-staged implant treatment, where the height remained similar from implant placement to 12 months after crown restoration.

In the present study, trends were observed indicating that with decreasing height of the keratinized mucosa, there were more mid-buccal mucosal recession and bone loss during the interval between crown insertion to three months later. Bengazi et al. (1996)¹⁴ correlated the presence or absence of keratinized mucosa to recession and did not find statistically significant relationship. There seems to be no other studies available evaluating the amount of keratinized mucosa to recession.

Trends were also observed in this study indicating that with decreasing thickness of the mid-buccal bone measured after osteotomy, there were more mid-buccal mucosal recession and bone loss during the period from crown insertion to three months later. Spray et al. (2000)²¹ studied the relationship between buccal bone thickness following osteotomy and vertical buccal bone loss for 2,685 implants during the interval between implant placement and abutment connection surgery. The mean buccal bone thickness after osteotomy was 1.7 ± 1.1 mm, measured approximately 0.5 mm apical to the crest. They found that when the mean buccal bone thickness was 1.8 ± 1.4 mm or less, bone loss was more likely to occur. Recession of the implant mucosa was not evaluated in their study.

Studies with observation periods varying from one to ten years have observed peri-implant soft tissue recession ranging from 0.4 mm to 1.8 mm.^{14,20,22-26} In a 1-year follow-up, Small and Tarnow (2000)²⁴ observed an average of 0.9 mm buccal recession. The

majority of the recessions occurred within the first 3 months after 1-stage implant surgery or abutment connection of 2-stage implants. In addition, they found that 82% of all buccal sites exhibited recession. Bengazi et al. (1996)¹⁴ reported an average of 0.4 mm buccal recession during the first six months after crown placement. Cardaropoli et al (2006)²⁰ observed a mean buccal recession of 0.6 mm one year after crown placement. In the present study, mean recession three months after crown placement amounted to 0.4 mm.

The magnitude of the mid-buccal probing depths in the present study was similar to findings by other authors who have made recordings on the same type of implants.^{17,31} Apse et al. (1991)¹³, Van Steenberghe et al. (1993)³² and Bengazi et al. (1996)¹⁴ observed decreasing probing depths around implants over time after prosthesis placement. The probing depths at crown insert and 3 months later in the present study remained stable. Continued recordings will disclose if changes will occur at later intervals.

Soft tissue height (clinical 'biologic width') was recorded in this study using bone sounding. The mid-buccal soft tissue height averaged 3.6 ± 0.7 mm at crown insert and 3.5 ± 0.8 mm after 3 months. These numbers are similar to those observed by Kan et al. (2003)²³ in a retrospective study of 45 single implants having neighboring teeth. They found that the mid-buccal soft tissue height averaged 3.6 ± 0.9 mm.

In conclusion, this 3-month report identified some pre-implant placement conditions that seem to predict relevant soft and hard tissue outcomes post-implant placement. Continued recordings over 12 months including additional implants are required for more definite conclusions.

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